Bridge and Structures Office
Washington State
Department of Transportation

Memorandum

TO: All Design Staff
FROM: Bijan Khaleghi
DATE: May 21, 2012
SUBJECT: Prestressed Girder Design Criteria

This design memorandum clarifies, summarizes, and updates WSDOT policy for design of prestressed girder bridges. The following criteria shall be used:

1. All computations including stiffness, stress, prestress losses, deflection and camber shall be based on gross section properties.
2. The allowable tensile stress in the precompressed tensile zone at the Service III Limit State is 0.0 ksi (see BDM 5.2.1C).
3. Girders shall be designed for flexure and shear based on the controlling condition of simple spans for all dead and live loads and simple spans made continuous for superimposed dead and live loads. The requirements of AASHTO LRFD 5.14.1.4 need not be satisfied (see BDM 5.6.2).
4. Time dependent prestress losses shall be computed by the refined method specified in AASHTO LRFD 5.9.5.4. The first paragraph of BDM Section 5.1.4.B is revised to read "The Approximate Estimate of Time-Dependent Losses of AASHTO LRFD 5.9.5.3 may be used for preliminary estimates of time dependent losses for precast, prestressed girders with composite decks as long as the conditions set forth in AASHTO are satisfied". BDM Section 5.1.4.C is revised to read "Final design calculations of time dependent prestress losses shall be based on the Refined Estimate of Time-Dependent Losses of AASHTO LRFD 5.9.5.4".
5. Bridges shall be designed for a future overlay in accordance with BDM Section 3.8 (Future 2" HMA overlay at a unit weight of 140 pcf).
6. The shear design shall be based on the simplified procedure for nonprestressed sections as specified in AASHTO LRFD 5.8.3.4.1 and the general procedure for prestressed sections as specified in 5.8.3.4.2.

Background:

The current AASHTO LRFD recommends a minimum service life of 75 years for bridge structures. Conservative bridge design policies leave a margin of safety for prestressed girder bridges for unforeseen demands over the life of the structure. Supporting reasons for the conservative design policies for prestressed girder bridges include:

1. Historical increase in bridge live load: AASHTO design live loads have been increasing over the past few decades from HS-15 to HS-20 to HS-25, and to HL-93 in 1994.
2. Increasing use of overload trucks: The majority of bridges in Washington State are precast-prestressed girder structures. Virtually every permitted overload vehicle crosses a precast-prestressed girder bridge. Overloads often exceed the AASHTO specified design live loads. The reserve capacity due to conservative design practices allows prestressed girder bridges to withstand the overload trucks. Commerce would be adversely affected if these overloads could not be safely and conveniently moved. It should be noted that trucks carrying long-span prestressed girders are among the heaviest loadings ever permitted in Washington State.
3. Increase in number of traveling lanes: Due to increasing traffic volumes, lane widths on some routes have been reduced from 12 feet to 10 feet to accommodate more traffic lanes. The reserve design capacity allows prestressed girder bridges to accommodate increased traffic demand and conform to the minimum requirements specified by AASHTO without strengthening or other modifications.
4. Periodic change in Bridge Design specifications: AASHTO design specifications have been changed from allowable stress design (ASD) to load factor design (LFD) and to load and resistance factor design (LRFD). More stringent design requirements have been observed with each change in design specifications.
5. Reserve capacity for girders damaged by over height collisions: The over height load collisions on prestressed girder bridges often results in broken strands that need to be repaired. Prior to repairs being made, the reserve capacity of the undamaged girders helps to keep the bridge in service. The current practice for splicing and re-tensioning broken strands limit the stress level to values lower than the original design. The reserve capacity due to conservative design practices allows repaired prestressed girders to satisfy design requirements.
6. Uncracked concrete under service conditions: The zero tension policy ensures that prestressed girders remain uncracked for flexure under service load conditions and overloads, resulting in longer service life.
7. Increased shear capacity: The conservative policies results in designs that require additional prestressing strands. This increase in prestressing results in higher shear capacity due to the vertical component of the prestress force and reduced angle of the diagonal compression strut.
8. Reduced life cycle cost: The conservative design policies require more prestressing strands (and possibly an additional line of girders in wider bridges), but results in longer service life and lesser life cycle cost.

The conservative design policies are an inexpensive insurance policy against future events including increasing legal loads, changing specifications, and unforeseen physical distress to the structure. The premium for this insurance policy is a one-time expense for as little as a half a dozen strands per girder, or one additional line of girder in wider bridges. This is typically a negligible percentage of overall project costs.

If you have any questions regarding these issues, please contact Richard Brice at 705-7174 (BriceR@wsdot.wa.gov), or Bijan Khaleghi at 705-7181(KhalegB@wsdot.wa.gov)

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